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The geography of Brexit – what geography? Modelling and predicting the outcome across 380 local authorities

David Manley, Kelvyn Jones and Ron Johnston

ABSTRACT

Most of the analysis before the 2016 referendum on the UK's continued membership of the European Union based on opinion polling data focused on which groups were more likely to support each of the two options, with less attention to the geography of that support – although some regions, especially London and Scotland, were expected to provide substantial support for Remain. Using a recently-developed procedure for detailed exploration of large tables derived from survey data, this paper presents the result of a prediction of the outcome across local authorities in Great Britain using just two variables – age and qualifications. In relative terms, that prediction was reasonably accurate – although, reflecting the polls' over-estimate of support for Remain – it under-estimated the number of places where Leave gained a majority, as was also the case within local authorities where data were published by ward. The model's predictive value was enhanced by post hoc incorporation of information on turnout and the number of registered electors, and taking these into account there was little evidence of substantial, additional regional variation in levels of support for Leave. Overall, regions were relatively unimportant as influences on the referendum outcome once the characteristics of the people living there were taken into account.

KEYWORDS

Brexit, predictive modelling, local authorities, geography

In the months leading up to the United Kingdom's referendum on 23 June 2016 on whether to leave the European Union (EU) much discussion based on opinion polls focused on the likely outcome nationally. Relatively little attention was paid to the geography of support for the Leave and Remain campaigns, although there was some discussion of likely regional variations – both London and Scotland were expected to provide a larger majority for Remain than any other regions. Apart from reporting the predicted percentages for Leave and Remain, plus the Don't Knows, most other attention to the polling data focused on which socio-economic and -demographic groups were providing most support for each side, although the heading to one distinguished newspaper commentator's – Simon Jenkins – column on the issue was 'Gender, age and political party are no guide as to how we'll vote'.¹

After the referendum results were announced by each local authority in England, Scotland and Wales² attention again focused on which groups favoured Leave and which favoured Remain, with several commentators using ecological analyses combining the referendum outcome with 2011 census and other data for each local authority. These both attempted to identify those groups and explored whether there were any significant spatial variations; were residents of some regions more

¹ <https://www.theguardian.com/commentisfree/2016/mar/31/brexit-gender-age-political-party-vote> - accessed 12 October 2016.

² The result for Northern Ireland was reported for the country as a whole, although they were also disaggregated according to its 18 Parliamentary constituencies. As the opinion poll data deployed here did not cover Northern Ireland they are not included in the analyses; nor are those for Gibraltar, whose residents also voted in the referendum.

likely to support Remain than others, irrespective of their population composition? For example, Goodwin and Heath (2016) reported that 68 per cent of variation in the percentage voting Leave was positively related to the percentage of people aged 65 and over in a local authority and to the percentage of residents there with no educational qualifications; holding those patterns constant support for Brexit was lower in London and Scotland than elsewhere and slightly lower (marginally statistically significant only) the larger the number of EU migrants in the area. (On the voting pattern, see also Clarke et al., 2017, and Evans and Tilley, 2017.)

Such ecological analyses throw considerable light, if only implicit because of the potential for committing the ecological fallacy, on which groups within British society strongly favoured the UK leaving the EU. Goodwin and Heath (2016, 331) concluded that their findings:

... gave full expression to ... [deep] divides in Britain that cut across generational, educational and class lines. The public vote for Brexit was anchored predominantly, albeit not exclusively, in areas of the country that are filled with pensioners, low-skilled and less well-educated blue-collar workers and citizens who have been pushed to the margins not only by the economic transformation of the country over recent decades but also by the values that have come to dominate a more socially liberal media and political class. In this respect the vote for Brexit was delivered by the 'left behind' – social groups that are united by a general sense of insecurity, pessimism and marginalisation ...

Such a conclusion goes well beyond what the data show directly, and reflects wider interpretations of the referendum outcome. Furthermore, it suggests a clear geography to that outcome: support for Brexit was 'anchored' in those parts of the country where members of the 'left behind' groups are concentrated,³ with two regions standing out as separate from the rest: London (where the socially liberal political class are concentrated?); and Scotland (an increasingly separate polity where the dominant political party locates many of that country's problems emanating from London/England and sees the EU as a better arena for their solution).

Does that geographical argument stand up to greater scrutiny or is it that – in Agnew's (1990) terminology – the observed spatial differences in the outcome were only epiphenomenal, reflecting differences between places in their population composition rather than differences that are place-specific; did local environments matter? To address that question, this paper reports on a parallel exploration to that of Goodwin and Heath, plus others who have adopted an ecological approach: Harris and Charlton (2016, 11), for example, conclude that 'the UK is clearly fragmented with notable differences between people and places'. Following Agnew, this raises the question whether there are significant differences between places once those between people are taken into account.

To address that issue, this paper reports on research using a methodology that extends beyond ecological analysis, combining poll/survey with aggregate/areal data in a robust modelling framework. (For an alternative approach to the same general issue, see Hanretty, 2016.) It enables formal testing of the relative importance of 'people vs place' in appreciating what influenced the observed geography of the vote – of importance in later debates regarding whether the implementation of post-Brexit policies should be place-specific; overall, the results of the analyses presented here suggest that, with few exceptions, knowledge of an area's population characteristics was sufficient and additional information about place – region – provided little advance on that appreciation.

A predictive model

³ Jennings et al. (2016) suggest that these regions are also those with the highest levels of political discontent.

Voting behaviour in Great Britain, as elsewhere, is closely linked to people's social positions and related attitudes. This has been demonstrated regarding attitudes to the EU over the last two decades by variations in support for the United Kingdom Independence Party (UKIP), whose main policy platform has been that the UK should leave the EU. Most analyses have shown that this party has gained greatest support from those who have been relatively disadvantaged during the increased globalisation of the world economy over the last half-century (see, for example, Goodwin and Milazzo, 2015; Evans and Mellon, 2016; Cutts et al., 2017). They have not benefited substantially from the economic growth which accompanied that trend; indeed they may well have been disadvantaged by the widening income inequalities and it has been suggested to them – by some politicians and media outlets, for example – that this, in part, has been the result of the increasing scale of international migration associated with liberal trade regimes, not least that operated by the EU. (Net migration to the UK has exceeded 100,000 each year in the last decade.) They comprise what has been termed the 'anxious class', or the 'left behinds' (termed the 'precariat' by Standing, 2016), and their anxiety has been expressed through distrust of the politicians (across several parties) they consider responsible for the globalisation-related inequalities. This is linked to a belief, again strongly promoted by some media outlets and politicians, that withdrawal from the EU – regaining UK sovereignty and 'control of our borders' and being free to 'make our own laws' again – can reverse the growing inequality and result in increased life-chances for those currently disadvantaged (not least by improving both their employment prospects and their access to welfare state benefits in health, housing and education). Those beliefs are especially associated with older voters, particularly men, and those with few qualifications, who have provided the bedrock of growing support for the British main anti-EU political party – the United Kingdom Independence Party (UKIP), as shown in Jones et al. (2016).

If support for leaving the UK is concentrated among those groups, therefore, then it should be possible, by knowing where they live and their propensity to vote Leave before the referendum was held, to predict where support for that change would be strongest, and also to evaluate whether that compositional knowledge was sufficient to account for any observed spatial variation in support for Brexit. We use data from a long sequence of political opinion polls conducted between 15 March 2015 and 7 March 2016, comprising over 60,000 separate observations.⁴ Respondents were asked whether they favoured Leave or Remain or were Undecided.⁵ There was no substantial variation in the percentages for the three responses over the year-long period; overall some 56 per cent favoured Remain in each of the four quarters and 36 per cent favoured Leave, and so we did not use the time of the survey as a variable in the modelling.

[FIGURE 1 ABOUT HERE]

The polling data included several pieces of information about each respondent, which were explored to find the best predictors of support for the options. As described in detail elsewhere (Jones et al., 2016), we favoured a modelling approach built on Occam's Razor principles, but which – unlike many statistical models of voting behaviour – took into account the interactions between the chosen variables as well as the main effects that are the usual focus of such modelling. The goal was to generate a robust estimate of the proportion of members of each group likely to vote Leave across Great Britain's 380 local authority districts (LADs), given the variation within the polling data. Some cells of the matrices examined had large numbers of observations on which to base a precise

⁴ We are grateful to Anthony Wells of YouGov for making these data available to us.

⁵ The question offered five options: Strongly in favour of Britain remaining in the EU; Slightly in favour of Britain remaining in the EU; Don't know; Slightly in favour of Britain leaving the EU; and Strongly in favour of Britain leaving the EU. Initial analysis suggested no significant differences across the groups considered between the first and second and the fourth and fifth responses, so these were combined to give the threefold responses – Remain; Undecided; Leave.

estimate of the required proportion, whereas others had few and if they were given equal weight the resulting estimate could be biased.⁶ Further, since we were wanting to predict the outcome in each of the 380 separate reporting areas this gave a very large multi-variable matrix – in the final version selected for use here 5 age groups x 5 qualifications categories x 380 LADs x 3 outcomes (Leave, Remain, Undecided). The polling data were not evenly distributed across the LADs, as shown In Figure 1, so we deployed a modelling strategy which ensured that the support patterns in LADs with few respondents did not bias the overall estimate.

[TABLE 1 ABOUT HERE]

In determining which respondent characteristics (independent variables) to include in the model we were led by analyses of the 2015 general election results, using data from the British Election Study (BES) post-election survey and influenced by information on which groups the various referendum campaigns were focusing their efforts on (see Shipman, 2016). This showed that support for UKIP varied significantly by age, by sex, and by educational qualifications, including interactions among those three variables (Jones et al. 2016): older men with degrees were significantly more likely to vote UKIP than expected according to a null model of no difference by age, sex and qualifications; older women with degrees were not (Table 1). The figures in this table are the modelled ratios between the observed number of voters in that cell and the expected number given a null model of no difference across the cells. A value greater than 1.0 indicates more than expected and a value less than 1.0 indicates less; a figure in bold indicates a statistically significant difference from 1.0 at the 0.05 probability level or better.) Analysis of the EU referendum polling data showed no difference by sex when the other two variables were taken into account, however, and so the modelling focused on just age (in five groups), qualifications (also in five groups), and LAD (380).⁷

The modelling

The multi-level modelling approach applied here was developed for the prediction of health and health-related characteristics of local area populations, combining survey with census data (Twigg et al., 2000, 2006; Twigg and Moon, 2002; Mohan et al., 2005). National surveys can provide reliable estimates of differences across population groups in their propensity to adopt certain types of behaviour – such as smoking and drinking – but most of them are too sparse (have too few observations) to give similar reliable estimates of those propensities in separate geographical areas.

Multi-level modelling produces estimates of the extent to which individuals in each cell of a contingency table (in this case, age by educational qualifications) were nationally likely to vote Leave or Remain, or were Undecided. The multi-level model also contained terms that picked up the distinctiveness of each LAD after taking account of age and qualifications. Importantly, given the small number of respondents in some areas, this estimate of local difference is precision-weighted so that unreliable rates are shrunk back to the national estimate (Jones and Bullen, 1994). The national rates and local differences were then combined to derive a (5 x 5 x 3) probability matrix for each of the sub-areas being studied (the 380 LADs in this case). These 'local' probabilities of the outcome were then applied to the counts of the same predictor variables (age and qualifications) for each area obtained from the full enumeration of the 2011 census, thereby deriving a predicted count of those who were likely to fall into each outcome category.

⁶ For example, the final 5 x 5 matrix used in the modelling (five age groups and five educational qualification levels) had some cells with fewer than 250 respondents.

⁷ One possibility for this difference with regard to the sexes is that UKIP's leader, Nigel Farage, was considered unattractive by many women because of his association with smoking and heavy drinking. Women were much less discomfited by the leaders of the Leave campaign, however, notably Boris Johnson.

[TABLE 2 ABOUT HERE]

The national modelled pattern for age, qualification and Leave is shown in Table 2. Support for Brexit was, as expected, greatest among the older respondents and those with few or no educational qualifications, but the gradient between the least and the most qualified was steepest among the older age groups – justification for use of a modelling strategy that takes the interaction between the two variables into account. Thus there was little difference among those aged under 35 in their propensity to vote Leave whatever their qualifications level, whereas among older groups there were substantial differences; among those aged 65 and over, for example, individuals with no educational qualifications were 50 per cent more likely to vote Leave than those with Level 4 (degrees and their equivalents).

These estimates assumed that all adults voted in each area – indeed, that all were registered electors and were able to vote. This is clearly not the case. Turnout at recent British general elections has only been about two-thirds of the registered electorate – and that in turn is believed to be only 85 per cent complete. Furthermore, turnout is known to vary substantially across groups within the population: for the two groups studied here, the young are much less likely to vote than their older contemporaries, and those with no or few qualifications are similarly more likely to abstain than the well-qualified. To take these variations into account, therefore, we weighted the values in the matrix cells for each LAD according to a national estimate of likely turnout. For the latter, we used a matrix derived from the 2015 British Election Study (BES) post-election survey; as with all surveys this significantly under-states the number of abstainers, but as our interest was in relative rather than absolute rates of turnout between age and qualification groups we did not standardise the data further. The number of individuals in each 5 x 5 cell for each LAD was reduced by the relevant percentage, and the expected proportion voting Leave, Remain or Undecided then applied. That matrix was then used to get the overall estimated sums and proportions for each of the three outcomes for each of the 380 LADs. This led to an inflation of support for Brexit in all areas of up to 3.7 percentage points compared to the estimates assuming 100 per cent turnout, sufficient in a tight contest to determine the overall outcome there and hence in the number of areas where Leave had more support than Remain.

The modelled geography

The modelled geography of support for Leave is shown in Figure 2. This combines two elements – the compositional element due to local differences in the age and qualifications of people in different areas – and the contextual variations – the LAD differences in the polling data after taking account of the demographic variables. (That for Remain is virtually the mirror image of the pattern in Figure 2 since there was little spatial variation in the geography of the Undecideds – a mean of 0.11 with a standard deviation of 0.01⁸).

[FIGURE 2 ABOUT HERE]

As an initial check of the reliability of that predicted geography, and of Simon Jenkins's claim, we regressed the values for each LAD against the percentage who voted for UKIP at the 2014 European Parliament election, when that party – whose predominant policy was for the UK to withdraw from the EU – won the largest share of the votes. (Heath and Goodwin, 2016, undertook a similar check.) There is a reasonably strong relationship, with the main exceptions from the general positive trend being in Scotland (whose LADs are separately identified in Figure 3); UKIP performed

⁸ The regression is %Leave = 0.843 – 0.913%Remain: $r^2 = 0.978$.

uniformly poorly there in 2014 with a mean of just 0.11 (standard deviation 0.01) compared with the more differentiated situation in England and Wales (mean 0.33, standard deviation 0.08).

[FIGURE 3 ABOUT HERE]

UKIP voters formed the core of those who supported Leave two years later. Wave 9 of the 2015 BES survey, conducted after the referendum was held in 2016, showed that 95 per cent of those who voted for UKIP in 2015 voted Leave a year later: the comparable figures for the other parties were – Conservative, 62 per cent; Labour 32 per cent; Liberal Democrat, 28 per cent; Green, 20 per cent; SNP, 32 per cent; and Plaid Cymru, 23 per cent.

Testing the prediction

[FIGURE 4 ABOUT HERE]

Given that our modelling produced a reasonable post-diction of the 2014 election result, how accurate was its prediction of the 2016 referendum vote? Clearly the polling data used were wrong in expecting a majority for Remain (as were almost all other polls), but was the pattern of support for Leave consistent with that predicted; did we predict the relative levels of support across the 380 LADs correctly even if the absolute levels were wrong? The map of the predicted outcome suggests that was the case (compare Figure 4 with Figure 2), which the scatter plot of the observed support against the predicted in each of the LADs confirms (Figure 5). Reflecting the under-prediction of support for Leave overall, the slope of the regression between the two is steeper than 1.0, but the relationship between them is close.⁹ Our modelling, using the cross-classification of just two demographic characteristics across the 380 LADs, was successful in predicting the relative strength of support for Leave across the country (the goodness-of-fit coefficient showing that it accounted for two-thirds of the variation across local authorities).

[FIGURE 5 ABOUT HERE]

Extending the analysis

The modelling was largely successful, therefore, but that it did not produce an even closer fit raises questions of where it failed, in relative terms, either by substantially over- or under-predicting support for Brexit. In particular, was there geographical variation additional to any spatial patterning resulting from variations in the age and qualifications composition of local populations, which is taken into account in the model? Or were there other variables – excluded from the original modelling – that were significantly linked to support for the Leave option?

Regarding the latter element of that question, there was much concern during the pre-referendum campaign regarding two issues – turnout and electoral registration. As well-established in British electoral studies, there is a clear relationship between turnout and age; older people are much more likely to vote than their younger contemporaries.¹⁰ Where turnout is high, therefore, more young people are likely to have voted, so that areas with low turnout should – *ceteris paribus* – have shown greater support for Brexit. Turnout was high at the referendum (72 per cent, some six

⁹ The full regression is $\text{PropLeave} = -0.04 + 1.43 \text{ PredictedPropLeave}$; $r^2 = 0.67$

¹⁰ The BES post-referendum survey substantially underrepresented non-voting, but still showed a more than four-fold difference between those aged 65 and over and those aged 18-25 in the proportion of non-voters. Goodwin and Heath's (2016) ecological analyses of turnout at the referendum showed that it increased the larger the LAD's percentage of people aged 65 and over and decreased the larger the percentage of individuals with no qualifications; they did not explore the interaction between the two.

percentage points higher than at recent general elections) but it varied considerably, being relatively high in much of southern England but low across most of Scotland (Figure 6).

[FIGURE 6 ABOUT HERE]

The second issue concerns electoral registration. Although this is compulsory it was estimated that as many as eight million eligible voters were not on the electoral roll in December 2015 (Electoral Commission, 2016), and those disenfranchised individuals were concentrated among the young, ethnic minorities, recent migrants/movers, students, and flat-dwellers. Their absence from the electoral roll was exacerbated by a decision in summer 2015 to end the transition to Individual Electoral Registration (IER) early. (The legislation set December 2016 as the final date but gave the government the option of ending the transition a year early – which it did, against the advice of the Electoral Commission.) The electoral roll is recompiled each autumn and finalised in December of that year. Before 2015 one person in each household was required to register all eligible voters living there, but since then individuals have had to register themselves and in autumn 2015 if they were on the existing roll but did not apply to re-register they were removed; many were, especially among the groups just listed. Those not on the electoral roll at their current residence can apply to do so up to ten days before any poll, and much effort was expended during the first half of 2016 to encourage those not enrolled to register so that they could vote in the referendum. This had a varied response: in some places – notably several London boroughs plus the cities of Cambridge, Canterbury and Oxford, plus the borough of Slough – registration was increased by more than 10 per cent, but in some others the change was minimal.

High turnout and increased registration were likely to involve more young voters and thereby assist the Remain campaign, so across the LADs places with high turnout and large increases in the number of registered electors should display lower support for Brexit than predicted by our model. To test whether that was the case, turnout and registration change were included in a regression model with actual Leave vote in each LAD as the dependent variable and our predicted vote as a further independent. (Because data on electorate change were not available for all LADs in Scotland the regression including this variable was run for England and Wales only.) Models II and III in the regressions in Table 3 show that both of the additional variables were significantly linked to the pattern of voting Brexit, in the expected direction, and that their inclusion substantially improved the goodness of fit. Support for Leave was significantly lower than expected in places with high turnout and also in those with substantial increases in the number of registered voters in the months leading up to the referendum.

[TABLE 3 ABOUT HERE]

Given those differences, were there any further residual patterns; were there, as some commentators argued, regional variations indicative of geographical patterns of support for Brexit that were unrelated to the two demographic characteristics included in the models plus LAD differences plus turnout and registration change?; were people in particular regions – holding age and qualifications constant – more or less likely to vote for Brexit than their contemporaries elsewhere? To address this – for England and Wales only – a further model was run with a series of dummy variables representing regions, with West Midlands (which had the highest proportion of support for Leave – 0.60) as the comparator. The result, Model IV in Table 3, shows three regions where the mean support for Leave was significantly less than in the West Midlands: London, the Southeast, and the Northwest.

That local authorities in London and the Southeast on average gave less support to Leave than comparable places in the West Midlands (by as many as ten percentage points in the case of

London) suggests that in general residents of the country's most prosperous regions were – other things being equal – more favourably inclined towards membership of the EU than their contemporaries elsewhere. But was that the case across London as a whole? Figure 7 graphs the predicted proportions who voted Leave across LADs in England and Wales against the actual proportions, from Model III in Table 3 (i.e. excluding the regional variables). LADs in London (the 32 London Boroughs plus the City of London) are separately identified. Some, but not all, clearly deviate from the general pattern.

[FIGURE 7 ABOUT HERE]

The largest residuals from that regression are shown in Table 4 in unstandardised form: those where the observed vote for Leave was 10 percentage points or more lower than predicted are in the left-hand column; those where support for Leave was under-predicted by more than ten points are in the right-hand column. Although the two largest over-predictions (where support for Leave was 18-20 points less than on average for places with similar demographic characteristics, turnout and change in the electoral register) are in central London, as is the fourth largest, there is no clear evidence of a central London pattern: indeed, Enfield, where Brexit support was 10 points less than expected, is an outer suburb, as also is Richmond-upon-Thames (a borough which has given strong support to EU-favouring Liberal Democrat political candidates in recent decades: at the 2015 general election the seat was won by a Conservative candidate with 58 per cent of the votes; at a by-election in December 2016 following his resignation it was won by a Liberal Democrat candidate with just under 50 per cent of the votes, the party's candidate having obtained only 19 per cent at the general election). Five of the other LADs listed there are in the Southeast region. All are in London's commuter belt but none are in those parts of the Home Counties (such as districts in Essex and Kent) that contain concentrations of the 'left behind'. Three of those areas – Basildon, Medway and Thurrock – are in the list of areas where support for Leave was substantially under-predicted, as is Rushmoor (which contains one of the main concentrations of the British army in Aldershot and surrounding towns) but also Welwyn-Hatfield, part of London's Hertfordshire commuter-shed.

[TABLE 4 ABOUT HERE]

In general, therefore, these residuals from Model III do not suggest any further general features of a range of places that can account for the choices expressed there in the referendum; that they differ from the general trends appears to reflect individual place-specific influences. London and Scotland stand out as regions where average support for Leave was less than expected – other things being equal; that voters in the Northwest also gave slightly less support for Brexit than other regions is probably linked to its – and especially parts of Merseyside's – relatively large population of Irish descent (Irish politicians argued strongly that the UK should remain within the EU).¹¹ Elsewhere, knowledge of a local authority's age structure and its residents' educational qualifications was sufficient to account for over two-thirds of the variation in the voters' response to the referendum question, with information on turnout levels and the size of the electoral register adding strength to that conclusion.¹²

¹¹ Northern Ireland voted in favour of Remain by 56:44.

¹² We also fitted a series of Model Vs that incorporated interactions between region and our predicted Leave percentage. Several were slightly significant, but the only one of substantial interest – and the only one with a positive regression coefficient for the interaction variable – involved London. The positive coefficient indicated that the city, despite its low overall support for Brexit, was more polarised than other regions: where the percentage of old people with few qualifications was low, the percentage voting Leave was lower than expected: where there were large numbers of older, less-educated residents (mainly in some outer suburbs) the percentage voting Leave was less than expected.

Local variations

Although the referendum results were only to be published by LADs, a small number of authorities also published the outcome in each of their wards – though excluding the postal votes, which were counted centrally. We use those results for two cities – Birmingham and Plymouth – to provide a further test of our model's veracity.

[FIGURES 8 AND 9 ABOUT HERE]

For each city we took our estimated matrix of voting Leave by age and qualifications and applied those proportions to the 2001 census matrix of age by qualifications in each ward. This gave an estimated proportion voting Leave for each ward in each place, which could be compared with the actual proportions. As with the national pattern, the predictions understated the level of support for Leave, and in addition the predicted range across the wards in each place was much smaller than the actual variation. Nevertheless, as Figures 8 and 9 show, the relative pattern was fairly accurately replicated in both places: the r^2 value for the Birmingham equation in Figure 8 is 0.69 and for Plymouth in Figure 9 it is 0.60 – with no obvious major residuals in either case. (Note that in Birmingham especially the pattern of support for Brexit was much more varied across the forty wards than predicted by the modelling.) In each city the lowest support for Brexit was in the wards with most students and – in Birmingham especially – those with most members of Black and Asian minorities. Nationally, there was no relationship between an LAD's minority population and support for Brexit, reflecting the small size of such minority populations in most places; but where there were substantial concentrations – as in parts of Birmingham – support was much lower than expected given the age structure and qualifications of the population in those wards.

Conclusions

In part, the results of the analyses presented here do not differ substantially from those produced by other studies, using different, less-sophisticated modelling strategies. In confirming those findings, and thus their interpretations regarding which groups in the population favoured Brexit, however, the results of this modelling provide further insights into the socio-economic-political divisions within contemporary British society, in particular whether they are geographically-based. Support for Brexit was strongly focused in older age groups, especially older people with no or few educational qualifications, and to the extent that these are concentrated in particular areas – including those that have suffered most economically from the de-industrialisation and neo-liberalism policies initiated in the 1980s – then voting Brexit was spatially concentrated accordingly. Indeed, other than the interacted variables – age and qualifications – only three other clear patterns were identified across Great Britain as a whole. First, those places where turnout was high and where lots of people joined the electoral register in the six months prior to the referendum had lower support for Brexit than predicted by the basic model (I in Table 3). This suggests that where substantial numbers of younger voters were encouraged to register as electors and/or vote in the referendum – campaigns which were to a considerable extent place-specific – the Remain campaign performed better than average, as of course it did in Scotland, which is the second clear finding (although turnout averaged only 68 per cent there, compared to 72 per cent in Wales and 74 per cent in England). Finally, on average, too, London's boroughs gave below-average support to the Leave campaign, although later examination suggested that this was particularly concentrated in certain parts of the capital only.

There was a geography to voting for Brexit, therefore, and to a considerable extent it was a geography which matched that of the country's current socio-economic condition. It was not, however, a replication of earlier such geographies. It was not a simple north-south divide; nor did it

match the geographies of support for the three political parties that have contested all seats at general elections over recent decades – though it did closely match that of support for UKIP, the party that pressed for the referendum and argued strongly for Leave. Each of the country's two largest political parties were divided over the issue, among both their MPs and their supporters. Most Labour MPs supported Remain, but according to the British Election Study only 62 per cent of Labour voters in 2015 did so. Labour Brexit supporters were concentrated in its northern constituencies, as illustrated by the equal-area cartogram in Figure 10, which shows the constituencies won by the two major parties – Conservative and Labour – in 2015 according to the referendum majority. Of Labour's 232 seats, 148 returned a majority for Leave, including the great majority of those in northern England and Wales (Labour's traditional heartlands, along with Scotland where the SNP won all but three of the seats in 2015); only in London and several major cities (Birmingham, Leeds, Liverpool, Manchester, Newcastle and Sheffield) did some Labour seats return majorities for Remain. The great majority of Conservative constituencies outside London and the relatively affluent parts of the southeast voted to leave the EU.

[FIGURE 10 ABOUT HERE]

The Brexit negotiations that follow will need to satisfy the concerns of those who voted for Leave, both tackling the local conditions in the areas where they are concentrated and rebuilding trust there in the national political parties and politicians. (After the referendum UKIP increased its campaigning in areas of traditional Labour strength in the north of England where many of the 'anxious class' feel that a London-focused Labour party no longer represents their interests;¹³ at a by-election in Stoke-on-Trent, where Leave obtained 69 per cent support in the referendum, UKIP failed at its first post-Brexit attempt to displace Labour, however, winning only 24.7 per cent of the votes, compared to 22.7 per cent at the 2015 general election.) As Los et al. (2017) have shown, the regions that gave strongest support to Brexit have benefited most from exporting goods to the EU in recent years. At the same time, policies will need to reassure those in the areas which supported Remain that the economic prosperity delivered there by decades of neo-liberal globalisation will be sustained, otherwise those areas too may develop increasing distrust in the political class. A divided country is not easily governed, particularly an almost evenly-divided country.

Finally, the analyses reported here are based on a modelling strategy designed to predict spatial patterns when one of the data sets deployed – derived from surveys or polls – is insufficiently large to provide robust information about the situation across a range of places. That strategy has as yet not been widely deployed, but its use here has clearly demonstrated its utility in exploring the geography of a vote before it has taken place, given the availability of polling and census (or similar) data. The modelling reported here used just two characteristics of the individuals polled – and interacted them rather than treating them as separate variables – yet it predicted the geography of voting well before the event with considerable success, not only at the macro-scale of local authorities across the entire country but also at the micro-scale of wards within individual authorities. Apart from its academic interest, therefore, this approach has considerable potential applied value: it can focus attention on areas where campaigning might be concentrated, for example.¹⁴ A tool developed more than a decade ago has been under-utilised in the analysis of a

¹³ <http://labourlist.org/2016/10/james-morris-labour-has-taken-working-class-voters-for-granted-ukip-offers-them-a-political-choice/> (accessed 31 October 2016)

¹⁴ Our predictions were published in April, some three months before the referendum, and attracted considerable attention in the financial service industries. Because the actual results were to be published by LAD as they were ready, and this was expected to cover several hours, speculators (in the value of the pound, for example) were interested to know how soon they could be certain of the outcome during that sequence of result publication. (As it happened there was no clear pattern that areas that were likely to support one option rather than the other would declare later or sooner.)

potentially wide range of patterns; this paper should revive interest in its potential for understanding local environmental variations.

There has been much tension in debates regarding a wide range of public policies in Great Britain as to whether they should be focused on people – irrespective of geography – or on places. The result of the EU referendum has rekindled such debate: the Prime Minister appointed soon after the result made clear that her government’s policies would focus in particular on those ‘just about managing’ (the JAMs) – the people who provided the greatest support for Brexit. Should those policies have a spatial component? The analyses reported here imply not, because – with the exceptions of London and Scotland – there were no clear spatial variations in the proportion who voted to leave the EU once major socio-demographic differences were taken into account. But it is difficult to disentangle people and places – the types of people who supported the Leave campaign were concentrated in particular places (albeit very different ones, ranging from declining seaside resorts through to areas that have experienced substantial de-industrialisation). Designing policies to satisfy both the JAMs, who expect major changes in their economic and social well-being as a result of the UK’s departure from the EU, and those who favoured Remain, who do not wish their well-being to suffer as a consequence of the withdrawal, will require a great deal of geographical sensitivity if trust in the political apparatus is to be rebuilt across the country.

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Table 1. Differences by age, sex and educational qualifications in voting UKIP at the 2015 general election. (Rates significantly different from the overall rate of 1.0 are shown in bold.)

Sex	Female				Male			
Qualifications	1	2	3	4	1	2	3	4
18-25	0.79	0.75	0.39	0.30	0.91	1.10	0.63	0.58
26-35	1.16	0.80	0.69	0.35	1.34	0.96	0.73	0.48
36-45	1.48	1.17	0.91	0.51	0.95	1.63	1.03	0.68
46-55	0.77	1.46	1.03	0.69	2.23	1.91	1.26	1.06
56-65	1.67	1.49	0.90	0.69	2.14	2.05	1.24	1.14
65<	1.57	1.21	0.99	0.84	1.89	1.60	1.40	1.22

Column 1 refers to those with no or only level 1 qualifications; columns 2-4 refer to those with levels 2, 3 and 4 qualifications respectively.

Table 2. The predicted proportion of individuals in Great Britain in each age and qualifications category who would vote Leave.

Age/Qualifications	None	Level 1	Level 2	Level 3	Level 4
18-24	0.16	0.21	0.22	0.19	0.14
25-34	0.26	0.31	0.32	0.28	0.21
35-49	0.37	0.43	0.43	0.38	0.28
50-64	0.49	0.54	0.53	0.47	0.35
65<	0.60	0.63	0.62	0.54	0.40

Table 3. Regressions of the proportion voting Leave in each LAD.

Model	I	II	III	IV
Constant	-0.035 (0.021)	0.145 (0.045)	0.342 (0.046)	0.510 (0.052)
Predicted Leave	1.433 (0.052)	1.501 (0.053)	1.354 (0.054)	1.183 (0.051)
Turnout	-	-0.281 (0.062)	-0.418 (0.059)	-0.527 (0.063)
Change in Register	-	-	-0.626 (0.144)	-0.460 (0.133)
Region (comparator: West Midlands)				
London	-	-	-	-0.100 (0.013)
East of England	-	-	-	-0.012 (-0.011)
East Midlands	-	-	-	0.007 (0.011)
Southeast	-	-	-	-0.031 (0.011)
Southwest	-	-	-	-0.022 (0.012)
Northwest	-	-	-	-0.035 (0.012)
Yorkshire/Humber	-	-	-	-0.002 (0.013)
Northeast	-	-	-	-0.006 (0.016)
R ²	0.668	0.684	0.717	0.778
N	380	380	348	348

Table 4. The largest residuals from Model III

Local Authority	Region	Difference	Local Authority	Region	Difference
City of London	London	-0.20	Amber Valley	E Midlands	+0.17
Kensington & Chelsea	London	-0.18	N Warwickshire	W Midlands	+0.14
Sefton	Northwest	-0.13	Newcastle-under-Lyme	W Midlands	+0.12
Islington	London	-0.12	Medway	Southeast	+0.12
East Hampshire	Southeast	-0.12	NE Lincolnshire	Yorkshire	+0.11
Mid Sussex	Southeast	-0.12	Welwyn-Hatfield	East	+0.11
Wycombe	Southeast	-0.12	Taunton Deane	Southwest	+0.10
Tunbridge Wells	Southeast	-0.11	Basildon	East	+0.10
Southwark	London	-0.11	Thurrock	East	+0.10
Richmond-upon-Thames	London	-0.10	Rushmoor	Southeast	+0.10
Merthyr Tydfil	Wales	-0.10	South Holland	East	+0.10
South Hams	Southwest	-0.10			
South Bucks	Southeast	-0.10			
Enfield	London	-0.10			

Figure 1. Histogram of the number of observations for each local authority in the polling data set.

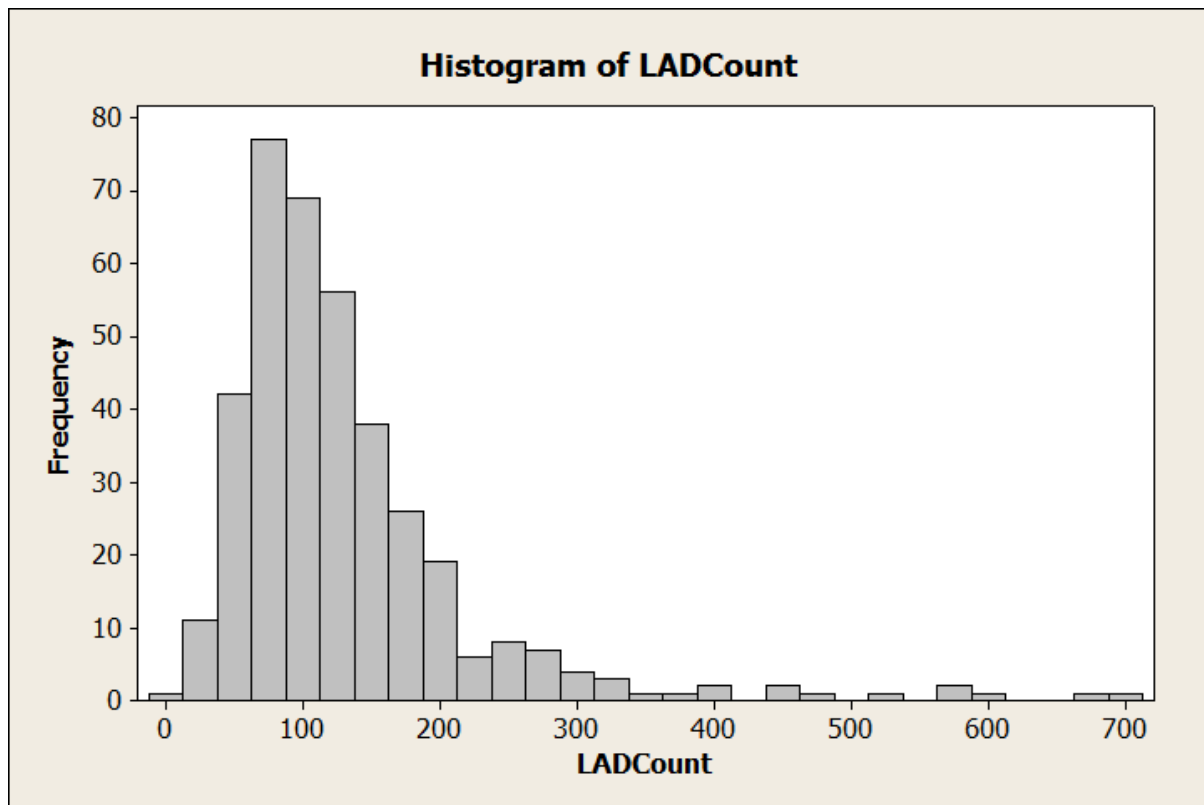


Figure 2. The predicted geography of voting Leave – those where the predicted percentage voting Leave exceeded the predicted percentage voting Remain are separately identified.

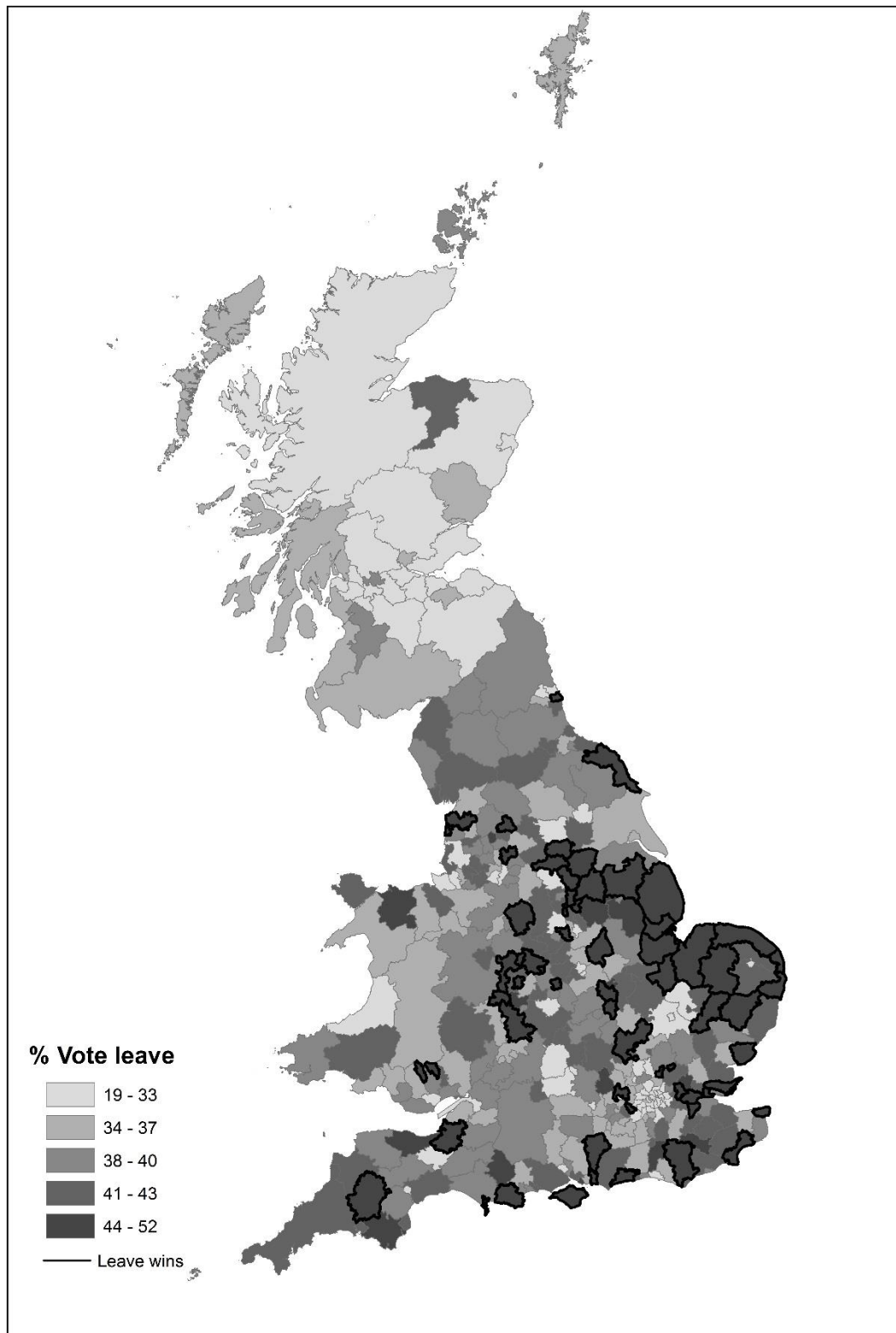


Figure 3. The relationship between the proportion voting Leave in the 2016 referendum and the proportion who voted for UKIP at the 2014 European Parliament election. (LADs in Scotland are separately identified.)

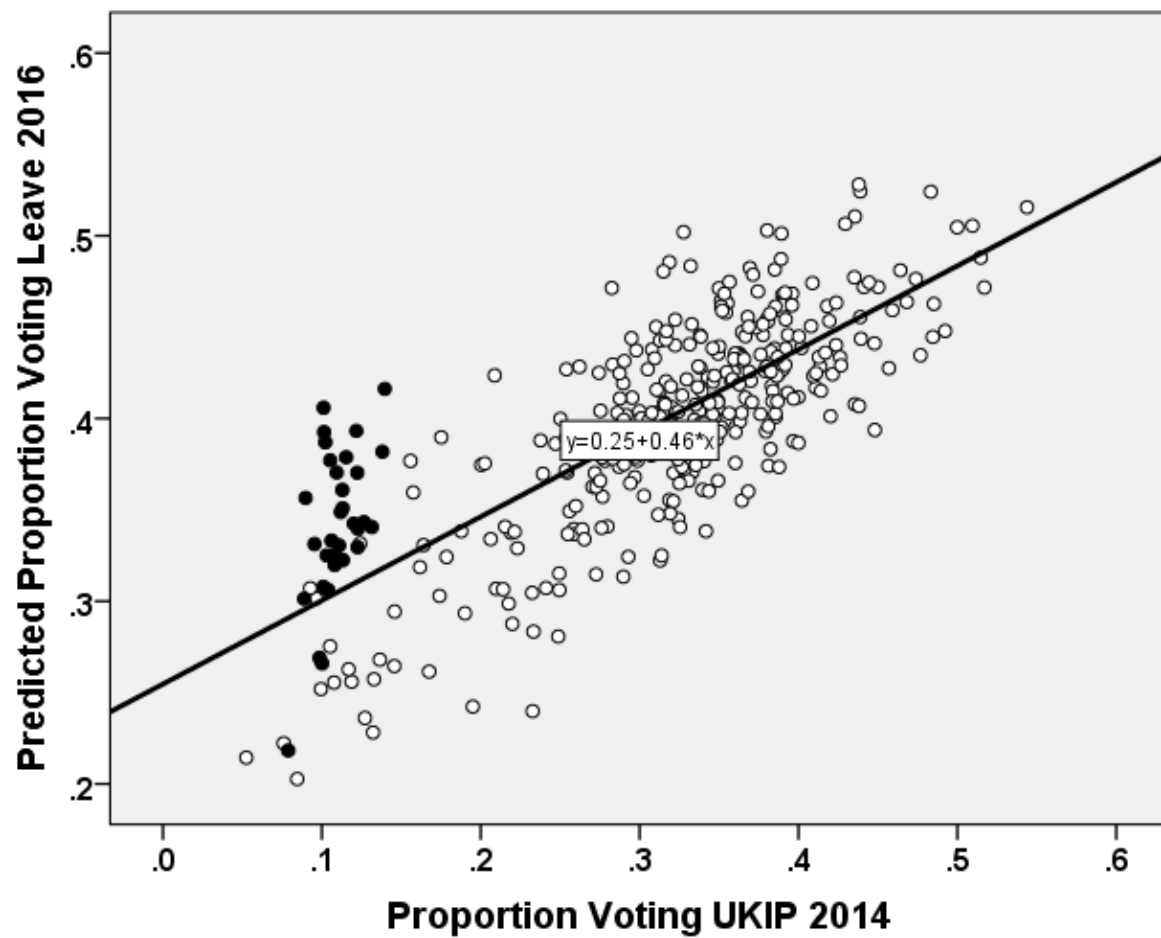


Figure 4. The result of the 2016 referendum: the percentage who voted Leave

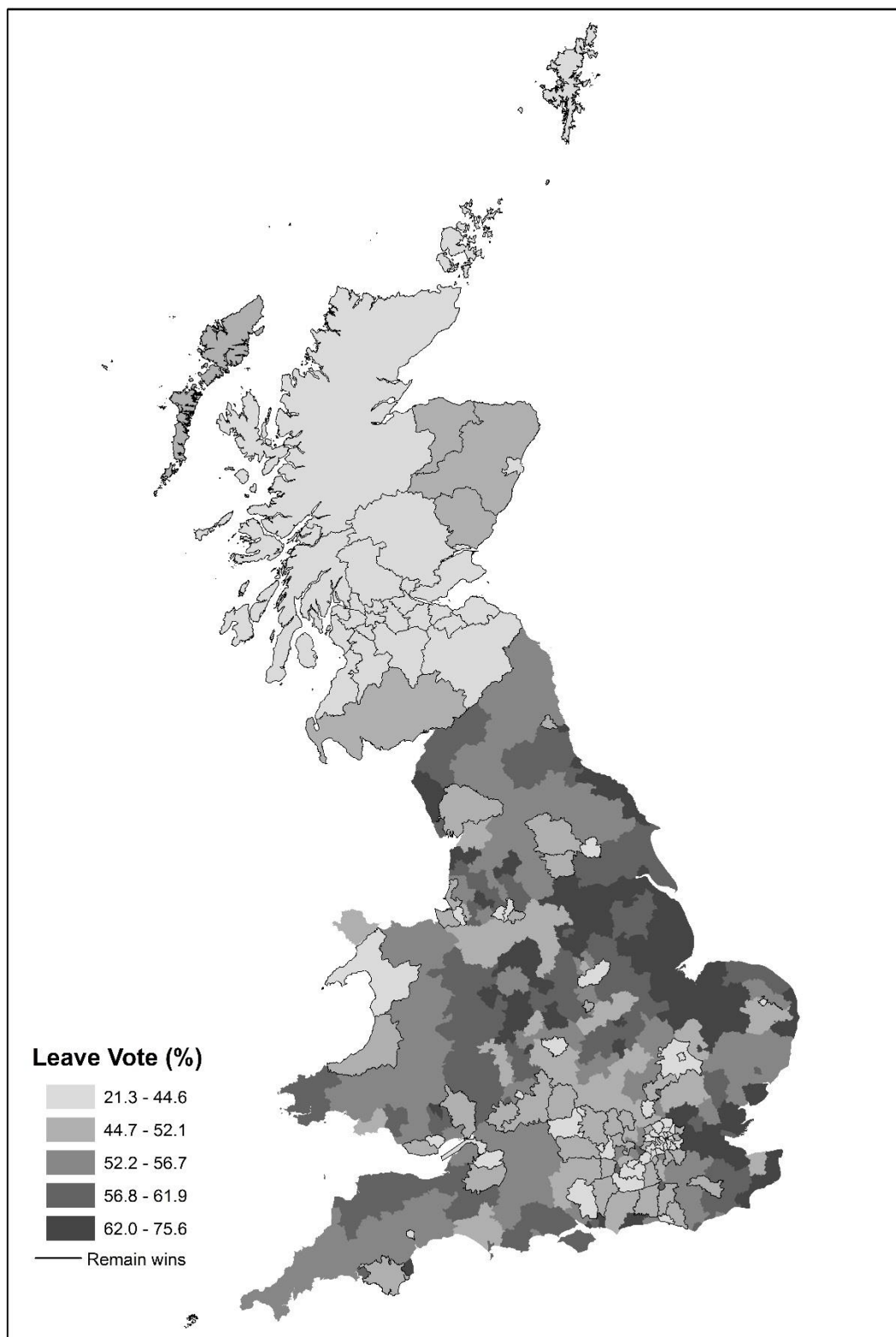


Figure 5. The relationship between the proportion voting Leave and the predicted proportion (Model I in Table 3)

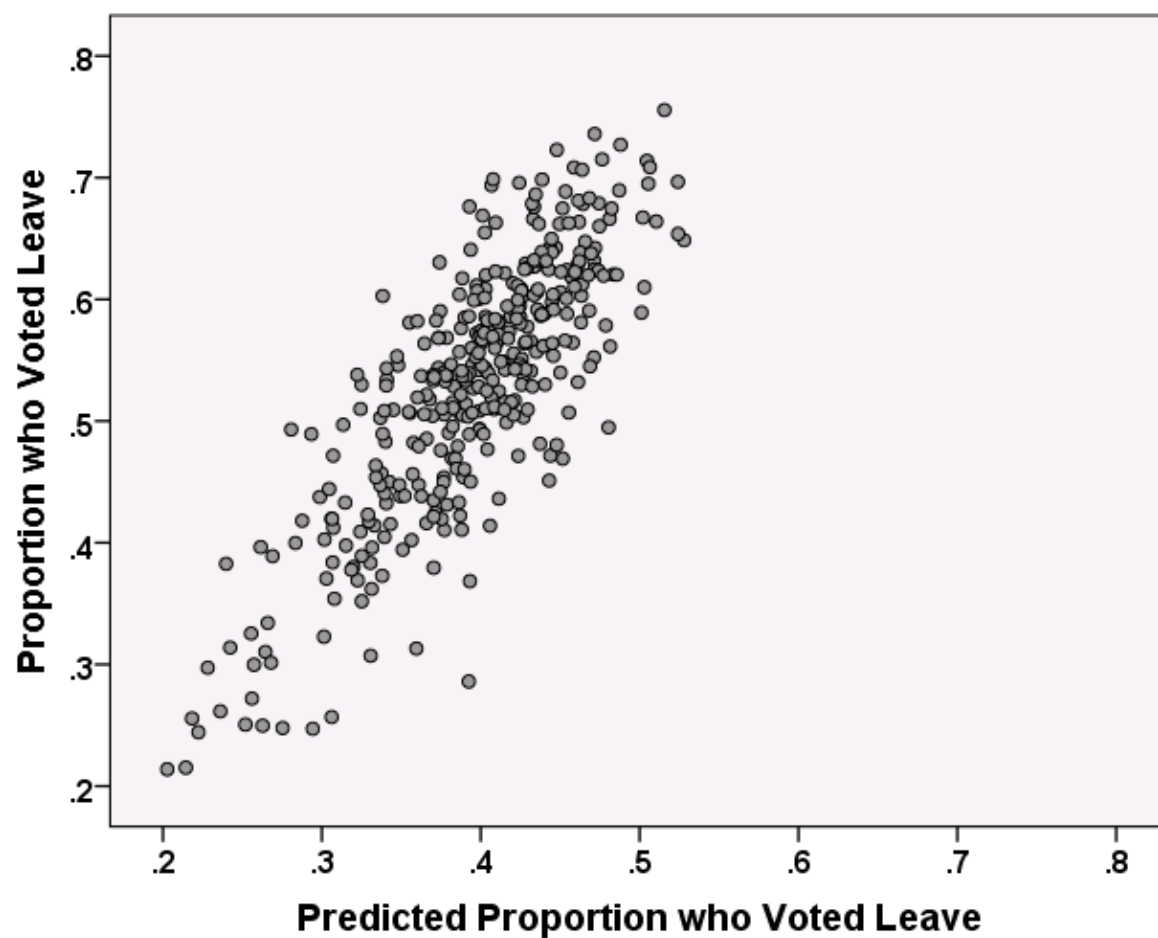


Figure 6. Turnout at the referendum

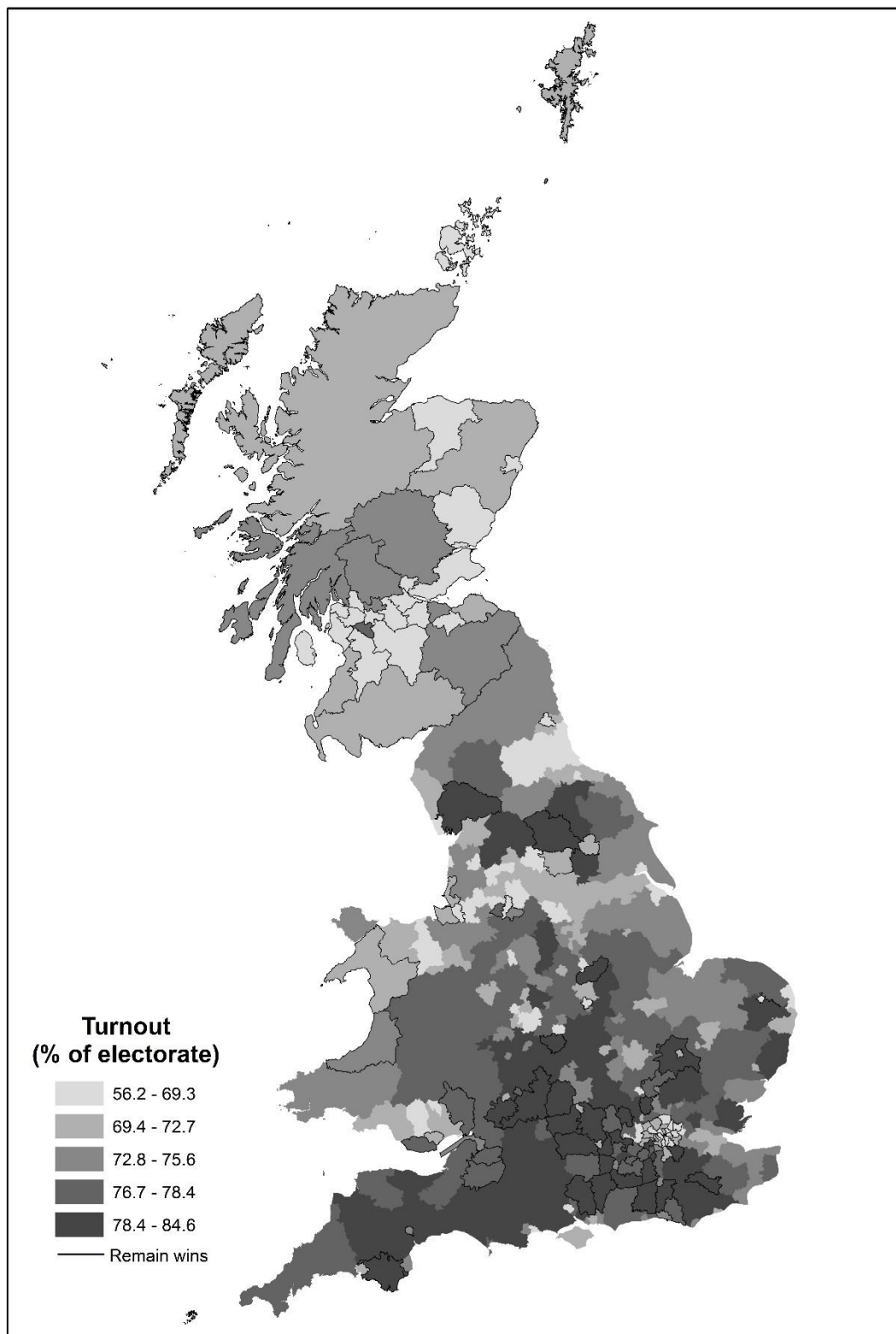


Figure 7. The relationship between the proportion voting Leave and the predicted proportion from Model III (Table 3) (London boroughs are separately identified).

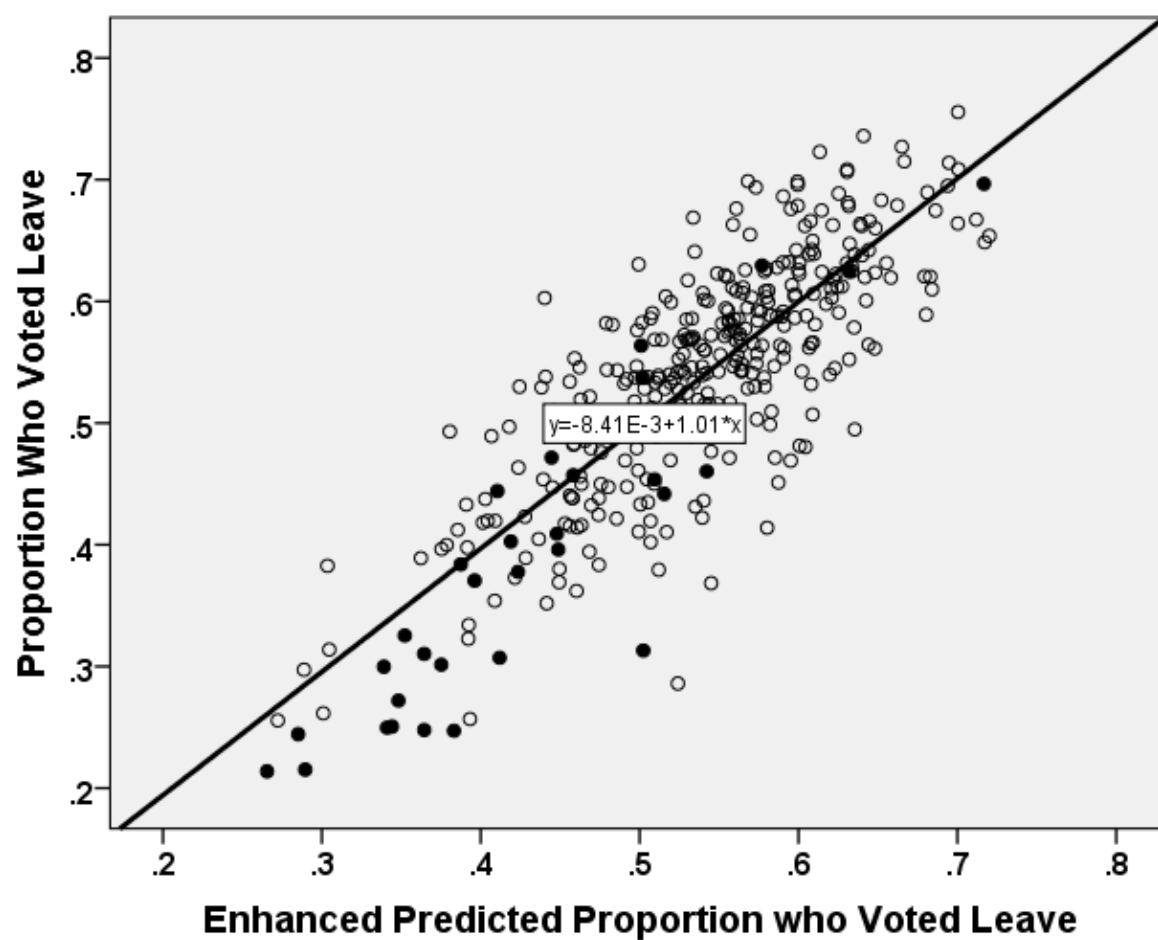


Figure 8. The predicted and actual proportions who voted Leave in Birmingham's wards

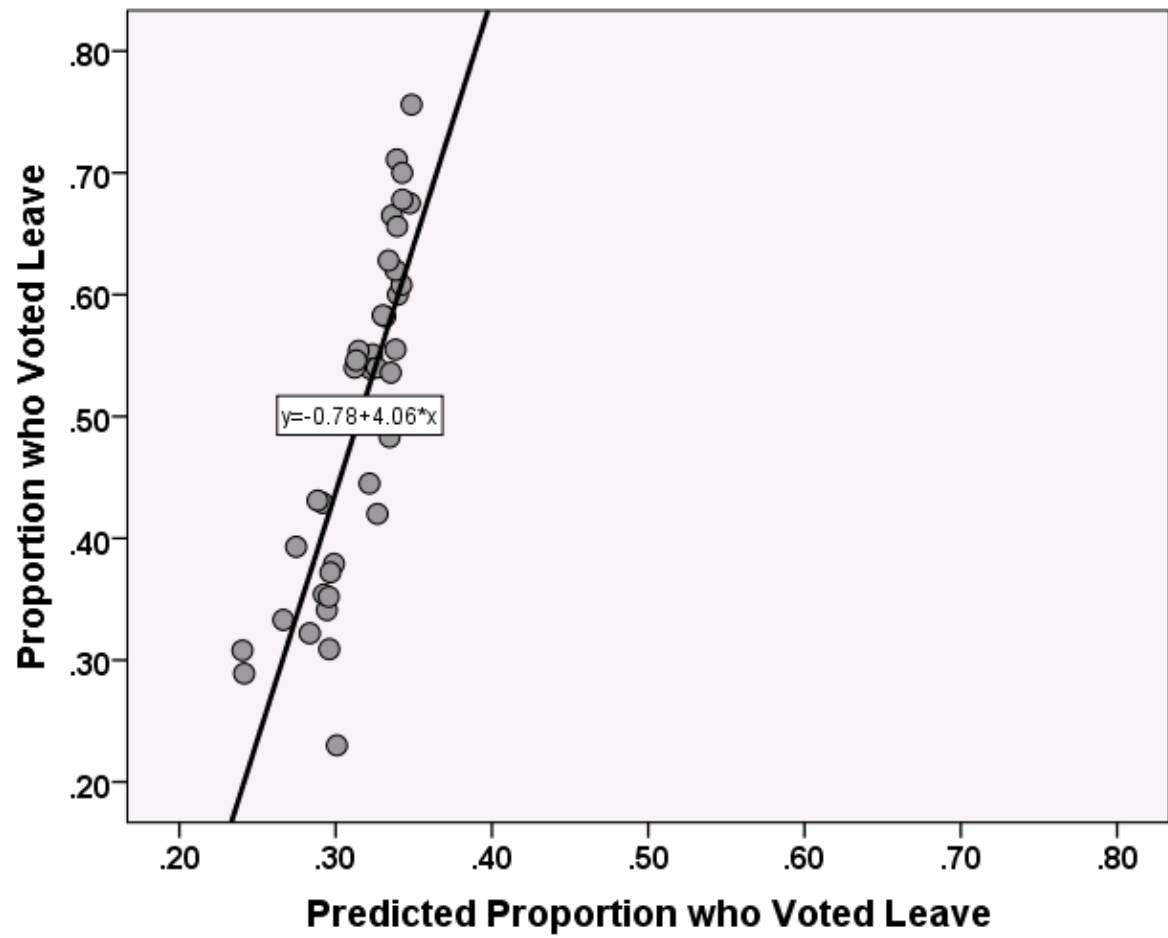


Figure 9. The predicted and actual proportions who voted Leave in Plymouth's wards

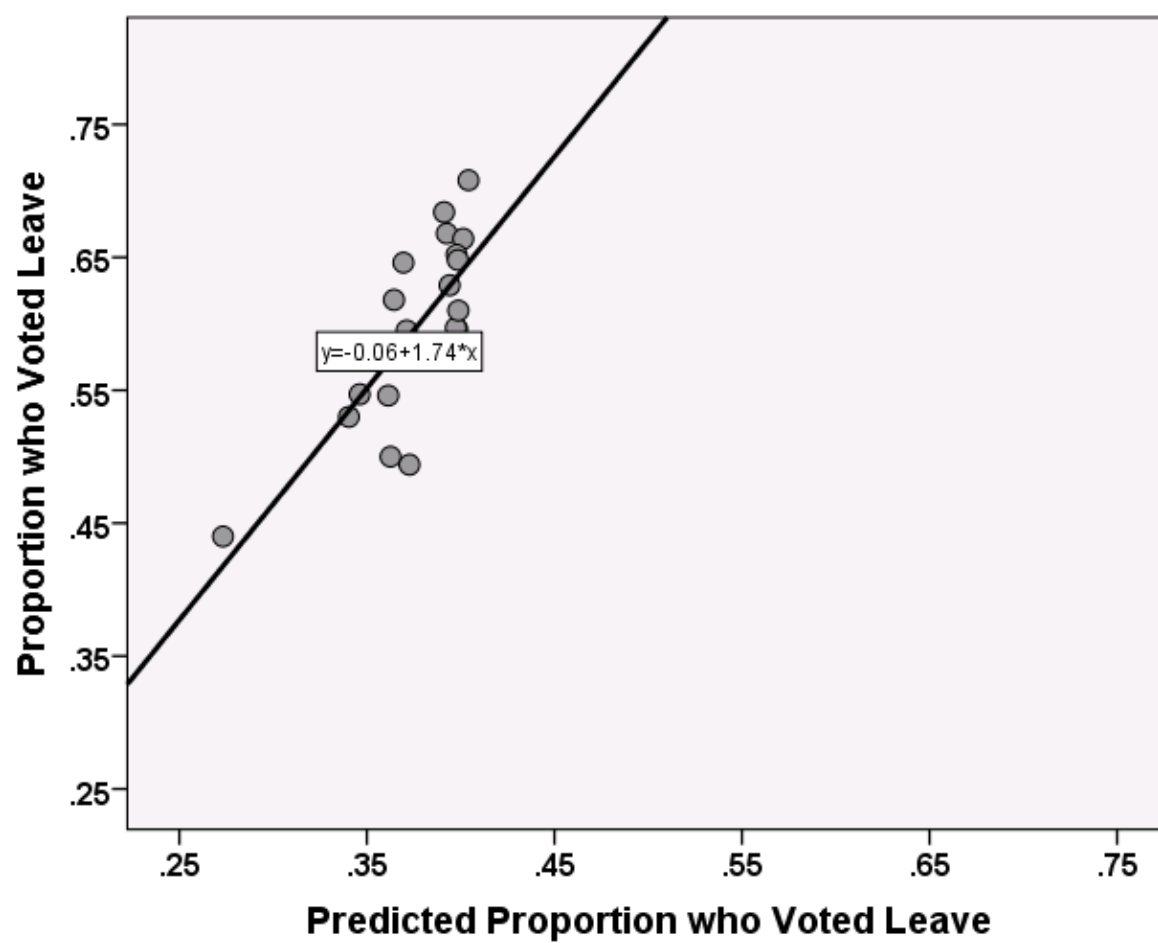


Figure 10. An equal-area cartogram of British constituencies showing the outcome of the 2015 general election and the (estimated) Brexit vote in each for the Conservative and Labour parties.

